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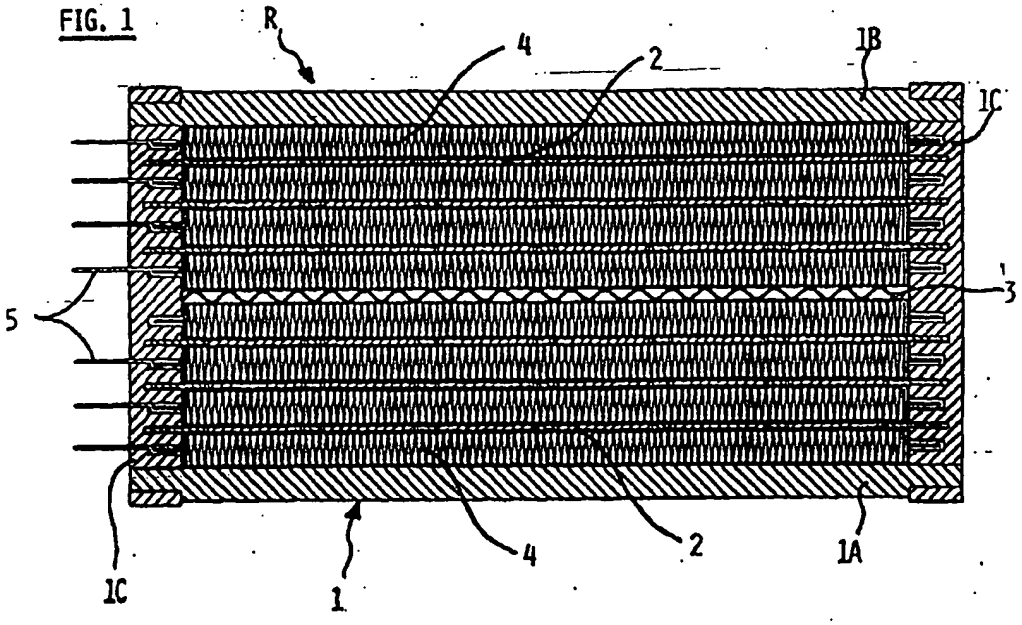
(54) Electric radiator

(57) A radiator, in particular for the use on motor vehicles, comprising a supporting body (1), where one or more heat emitting elements (2) extend between two first sides (1C) of said body, said heat emitting elements comprising one or more electric resistors, in particular positive temperature coefficient resistors, and being in contact with at least a heat dissipating element (4), the latter being in particular assembled mounted in said supporting body (1) in a substantially position with respect to the heat emitting element (2) in contact with it, where in said supporting body (1) elastic means (3) are further provided, which generate a thrust to press at least one of the dissipating elements (4) provided on at least one of the heat emitting elements (2), or vice-versa. According to the invention, said elastic means comprise at least one elastic device (3) located in an intermediate position between two dissipating elements (4) and/or two heat emitting elements (2) and/or a dissipating element (4) and a heat emitting element (2), being operative for pushing them towards respective opposite directions.

FIG. 1



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Description

[0001] The present invention-ref rs to a radiator, in particular for the use on motor vehicles, comprising heat emitting elements heated by electric resistors with a positive temperature coefficient, usually known as PTC resistors.

[0002] Resistors as described above are known and utilized e.g. in the heating systems for motor-vehicle passenger compartments, wherein warm air is required nearly instantaneously to defrost a windshield or rear window, i.e. to remove their fogging.

[0003] It should be noticed, in this connection, that heating systems for more conventional vehicles do not generally provide such a fast function, since they use as a heating medium the same fluid circulating in the internal combustion motor of the vehicle itself, i.e. they are able to generate the heat required for air heating only after a certain period of time following motor start up. In this frame, it is clear how in certain circumstances, typically during the coldest months of the year, a satisfactory direct air heating in the passenger compartment of the vehicle may require a considerable long time.

[0004] To this purpose heating systems using common electric heating elements as their heating medium have been suggested.

[0005] However, these systems may cause an overheating risk and consequent melting of the heating elements, should the air flow to be heated stop for any reason, such as the failure of a circulation fan or an accidental occlusion of the duct path for the air flow to be heated. In order to prevent such a drawback, appropriate thermostatic protection means should be provided, with a consequent more complex manufacture of the heating system and costs increase; in addition, it should be remembered that also the above thermostatic safety means may undergo a malfunction with consequent risks.

[0006] In order to overcome the above drawbacks, radiators using electric resistors with a positive temperature coefficient as heating elements have been suggested, which are generally known as PTC resistors (*Positive Temperature Coefficient*).

[0007] The features of PTC resistors are well known and do not require a deeper description here; however, it is pointed out that such resistors usually have a body made from appropriate ceramic material with a relatively thin cylindrical or parallelepiped shape, whose larger flat surfaces have a superficial metallization appropriate for ensuring electric contact and thermal exchange.

[0008] When in a cold state, PTC resistors are featured by a low electric resistance, which increases on the contrary with their increasing temperature, so that the current flowing across a PTC resistor will gradually decrease as the temperature of the latter increases. Therefore, when the electric current is directed across a PTC resistor, the material forming it heats up increasing its own resistance; thus, the current flow through the resistor and consequently also its thermal power will be reduced. In general, when th thermal power of the resistor balances the amount of heat dissipated by it, temperature will stabilize and limit the resistor current at a predetermined level.

[0009] Therefore, such a temperature self-control capacity of PTC resistors will prevent the risk of overheating; however, due to this self-control capacity, it should also be considered that the heat generated by a PTC resistor must be efficiently dissipated.

[0010] For this reason, an efficient heat exchange between the resistors and the diffusion medium surrounding them is required to manufacture a radiator employing PTC resistors. Moreover, considering the high initial electric current absorption of a PTC resistor (due to its low initial resistance), a good large contact surface has to be provided.

[0011] These issues are discussed for example in EP-A-0 350 528. This document describes a radiator comprising a supporting frame, which consists of an upper cross member, a lower cross member, two side uprights and an intermediate metal cross member between the upper and lower cross members.

[0012] A plurality of elongated heat emitting elements are provided in the frame itself, extending parallel to each other in the plane established by the frame. The heat emitting elements comprise each one two metal strips parallel to each other, as well as a plurality of PTC resistors located side by side between said two metal strips, whereby the opposite plane surfaces of the resistors are in contact with a respective metal strip and electrically and thermally connected; the resistors are maintained in their position between both metal stripes by means of appropriate plastic elements with through-holes, whose section is apt for receiving said resistors, also operating as isolators between said strips. The metal strips are supported at their ends and electrically isolated from each other also by means of the above side uprights of the supporting frame, which are accordingly fitted with suitable electric connecting elements.

[0013] As a main dissipating element in the air of the heat generated by the PTC resistors, folded foils (substantially like an accordion) made from a good heat conducting material are provided, which extend across the lengthwise axis of the heat emitting elements; such foils abut on two adjacent heat emitting elements or on a heat emitting element and one of said cross members of the supporting frame.

[0014] As previously mentioned, for radiators being manufactured with PTC resistor, a sufficient heat exchange between-the-resistors-themselves and the diffusion medium surrounding them, such as air, and a good electric contact need to be ensured. According to the disclosure of EP-A-0 350 528, dissipation or diffusion of the heat generated by PTC resistors in the air is obtained through the above folded metal foils and metal strips between which said resistors are arranged. Obviously, the better the contact between PTC resistors,

metal stripes and folded foils, the more efficient heat exchange with the air will be.

[0015] This is the reason why, according to EP-A-0 350 528, in order to warrant an efficient heat transmission, the whole metal strip surface has to be maintained in real contact with the PTC resistors. To this purpose, the upper and lower cross members of the supporting frame incorporate spring elements, which press the metal strips, by means of the folded foils; as a result, it is also advantageous to assemble the metal strips in the side uprights enabling the first ones to perform a limited movement within the second ones, so that the folded foils are able to actually transmit the force released from the spring elements to the metal strips packing the PTC resistors.

[0016] Therefore, in other words, the basic idea of EP-A-0 350 528 is to ensure a constant mechanical pressure between the above components, which is obtained by means of an appropriate configuration of the upper and lower cross members of the supporting frame, each one consisting of:

- an inner metal stripe in contact with the folded foils located in the upper and lower section of the radiator,
- a rigid outer bar extending in parallel and at distance from the inner stripe, and
- a spring device arranged between the outer bar and the inner bar, which rests on the first. one and presses the second against the adjacent folded foils.

[0017] Thus, the action of the spring devices incorporated in the frame upper and lower cross members is released either downwards or upwards, respectively, so as to have the folded foils, metal strips and PTC resistors constantly pressed towards the frame intermediate cross member; to this purpose, as said above, the metal strips are allowed a certain degree of mobility with respect to the side uprights.

[0018] The solution described in EP-A-0 350 528, though being fairly efficient, has some drawbacks.

[0019] A first drawback is due to a certain manufacturing complexity of the radiator. As said above, in fact, the frame upper and lower cross members have a composite structure comprising three distinctive elements to be assembled together, i.e. the inner metal stripe, the outer rigid bar and the spring device; moreover, also the side uprights need a special form for ensuring assembly and operation-of-the-cross-members so obtained.

[0020] Also the need of providing an intermediate cross member to form a further frame component makes the manufacturing rather complex; the same applies to the connecting elements for power supply to the radiator, which must be coupled by riveting to one of the metal strips packing the PTC resistors and to the intermediate cross member.

[0021] Moreover, as said above, both the spring devices incorporated in the upper and lower cross members of EP-A-0 350 528 exert a thrust towards the inside of the frame; this fact, besides not warranting an ven pressure distribution between the heat emitting elements and dissipating foils, also requires at least an intermediate cross member opposing to a certain ext nt the air flow through the radiator.

[0022] Another drawback of the solution described in EP-A-0 350 528 is that both spring devices and the relevant stripes they are pressing, even if made from a metal material, do not efficiently help dissipating the heat generated by the heat emitting elements, while not actually taking part at the heating of the air flow across the radiator. This is due to the circumstance that the spring devices and relevant stripes themselves are located in the inner section of the bar (or in its proximity) belonging to the frame upper and lower cross members (which frame is commonly incorporated in a proper seat of an aeration duct), thus resulting actually isolated from the air flow to be heated.

[0023] It is the object of the present invention to solve one or more of the above drawbacks of the known state of the art.

[0024] In this frame, an aim of the present invention is to provide an electric radiator comprising heat emitting elements heated by PTC resistors, which is easier to manufacture with respect to the existing solutions and employs simple and low-cost components.

[0025] A further aim of the present invention is to provide an electric radiator, wherein elastic means can be arranged, whose thrust can be more evenly distributed, in order to ensure an efficient contact between the heat emitting elements and relevant dissipating means.

[0026] A further aim of the present invention is to provide an electric radiator wherein the presence of elastic means has no negative results on the flowing air to be heated, and which does not require in particular intermediate cross members for a frame of the radiator itself.

[0027] A further aim of the present invention is to provide an electric radiator wherein the same elastic means are directly subject to the air flowing across the radiator, operating as heat dissipating elements and contributing to air heating.

[0028] A further aim of the present invention is to provide an electric radiator wherein the elastic means can be used as electric-conducting-elements, in order to simplify the supply system of the PTC resistors and reduce the number of electric terminals required to that purpose.

[0029] One or more of the above aims are attained, according to the present invention, by an electric radiator incorporating the features of the annexed claims, which form an integral part of the present description.

[0030] Further aims, features and advantages of the present invention will become apparent from the following detailed description and the annexed drawings, which are supplied by way of non limiting xample, wherein:

- Fig. 1 shows schematically in section an electric radiator according to the present invention;
- Fig. 2 shows schematically an lectric radiator according to the present invention through an exploded view of some of its components;
- Fig. 3 shows a first detail of an -electric radiator- according to the present invention;
- Fig. 4 shows a second detail of an electric radiator according to the present invention;
- Fig. 5 shows a third detail of an electric radiator according to the present invention;
- Fig. 6 shows schematically the principle of electric connection of the radiator represented in Fig. 1;
- Fig. 7 shows schematically in section an electric radiator according to a possible variant embodiment of the present invention;
- Fig. 8 shows schematically the principle of electric connection of the radiator represented in Fig. 7;
- Fig. 9 shows some alternative embodiments of a component of the radiator according to the present invention, through respective plan views and side views;
- Fig. 10 shows a schematic view of a component of the radiator according to a further possible variant embodiment of the present invention;
- Fig. 11 shows a schematic side view of a part of the radiator according to the present invention, in the event of a first type of utilization of the component represented in Fig. 10;
- Fig. 12 shows schematically a front view of a part of a radiator according to the present invention, as per the utilization shown in Fig. 11 of the component represented in Fig. 10;
- Fig. 13 shows schematically a side view of a part of the radiator according to the present invention, in the event of a second type of utilization of the component represented in Fig. 10;
- Fig. 14 shows schematically the principle of electric connection of a radiator as represented in Fig. 1, in the event a component like the one represented in Fig. 10 is used;
- Fig. 15 shows schematically the principle of electric connection of a radiator as represented in Fig. 7, in the event a component like the one represented in Fig. 10 is used;
- Fig. 16 shows schematically the principle of electric connection of a radiator as represented in Fig. 14, in the event two components like those represented in Fig. 10 are used;
- Fig. 17 shows schematically the principle of electric connection of a radiator as represented in Fig. 15, in the event a component like the one represented in Fig. 10 is used;
- Fig. 18 shows schematically the principle of electric connection of a radiator according to the present invention, highlighting a plurality of possibl variant embodiments.

[0031] Fig. 1 is a schematicrepresentation of a radiator manufactured according to the teachings of the present invention, indicated as a whole with R.

[0032] As it can be noticed, such a radiator R comprises a supporting frame, indicated as a whole with 1, which consists of a lower cross member 1A, an upper cross member 1B and two side uprights 1C, which are connected to each other at their respective ends; in the non limiting example described herein, both cross members 1A-1B and uprights 1C are made each one as a sole piece of a thermally and electrically insulating material, such as PPS, or nylon, etc.; preferably, even if the components 1A, 1B and 1C may have material undercuts, they have appropriate ribs, not shown, in order to ensure a sufficiently stiff frame 1 and prevent its distortions; in this way, therefore, any risks is avoided of transmission of electric voltage, temperature and mechanical efforts to the structure or the duct within which the frame is coupled.

[0033] A plurality of heat emitting elements 2 are arranged in the plane or space delimited by the supporting frame 1, which are coupled on their relevant ends to the uprights 1C, parallel to the cross members 1A and 1B,; in the case of Fig. 1, the heat emitting elements 2 are in number of six.

[0034] Reference 3 indicates an intermediate elastic device, extending parallel to the heat emitting elements 2; as it can be noticed, in the case of Fig. 1 the elastic device 3 extends between two substantially median points of the uprights 1C, so as to divide the inside of the frame 1 in two parts, for example being equal to each other, each one of them containing three heat emitting elements 2.

[0035] Reference 4 indicates some heat dissipating elements, which are arranged parallel and alternate to the heat emitting elements 2, and are coupled on their relevant ends to the uprights 1C.

[0036] As it can be noticed, the two dissipating elements 4 being distal from the center of the frame are in contact, on one side, with the cross members 1A or 1B, and on the other side with a respective heat emitting element 2; vice-versa, the two central dissipating elements 4 are in contact, on one side, with the elastic device 3, and on the other side, with a respective heat emitting element 2; each other dissipating element 4, on the contrary, is in contact with two heat emitting elements 2.

[0037] Reference 5 indicates some contacting elements or electric terminals, for example of the faston or clamp type, connected to one end of some dissipating elements 4; terminals 5 protrude out of the left upright 1C (with reference to Fig. 1) through appropriate passages defined in the latter.

[0038] Fig. 2, which partially uses the same reference numbers of Fig. 1, shows an exploded view of some components of the radiator of Fig. 1.

[0039] As it can be noticed also from the detail of Fig. 3, the end zone of the cross members 1A and 1B have portions 10, being of reduced section, on which engag-

ing teeth 10A are provided; from thes portions 10 projections 11 are departing, whos rectangular section is smaller with respect to the section of the portions 10.

[0040] The uprights 1C, on the contrary, have openings 12 on their two end zones, wherein the projections 11 of the cross members 1A-1B are apt to be inserted; appendixes 13 depart from the surface of the uprights 1C directed towards the inside of the frame, in correspondence with the passage 12; said appendixes 13 has engaging openings 13A being apt for receiving the teeth 10A of the cross members 1A-1B, in order to obtain a safe hooking; in order to make this engagement easier, the appendixes 13 are able to flex.

[0041] Seats 14, generally in the same number of the heat emitting elements 2 as well as passages 15, generally in the number of the dissipating elements 4 and/or the terminals 5, are defined on the inner surface of the uprights 1C.

[0042] Reference 2A indicates some known PTC resistors, which in the above example have substantially a flattened parallelepiped shape.

[0043] Reference 2B indicates a bar, made from electrically insulating material, such as a thermoplastic material, which is provided for retaining the PTC resistors 2A in position, in particular side by side and spaced from each other; to this purpose, through openings 2B1 are defined in the bar 2B, being of rectangular section and so dimensioned for housing the resistors 2A; the thickness of the bar 2B, in the portion defining the openings 2B1, is smaller than the thickness of the PTC resistors 2A, so as to avoid defective contacts between the latter and their respective dissipating elements 4; the bars 2B obviously operate also as electric insulators between the adjacent dissipating elements 4.

[0044] The ends 2B2 of the bar 2B are appropriately shaped for their insertion in the seats 14 of the uprights 1C; moreover, the bar 2B preferably has side edges 2B3, which are apt for warranting a correct positioning of the dissipating elements 4, as further explained in the following.

[0045] From the non limiting example described above it is clear how each heat emitting element 2 of Fig. 1 consists of several resistors 2A (namely, three) and a bar 2B of Fig. 2; obviously, each heat emitting element 2 might comprise the resistors 2A only, or other means for the purpose.

[0046] Reference 4A indicates a radiant element, consisting of a thin plate made from a good heat and electric conducting material, such as aluminium, which is folded on itself forming alternate angles on one and the other side, i.e. substantially folded in the form of an accordion or with a zigzag profile.

[0047] Reference 4B indicates some metal foils, such as aluminium, which form a means for containing the radiant elements 4A; preferably, foils 4B are thicker than the thin plates forming the radiant element 4A.

[0048] Each foil 4B is obtained by cutting and deforming one metal sheet, which in the above example delimits two specular parts 4B1, to be folded and/or fastened on ach other for containing or packing a radiant lement 4A.

[0049] In the above example, th end portions of the parts 4B1 have two orthogonal bends, i.e. to form a step ending in an extension 4B2 appropriately shaped; as it can be noticed from the detail of Fig. 4, during the cutting operation a thickness and/or width reduction 4B3 is operated in correspondence with the joining point between the two parts 4B1 or between both extensions 4B2, so that both parts 4B1 may be easily folded on each other with the interposed radiant element 4A; following this folding operation, both extensions 4B2 of one part 4B1 will rest on the two extensions 4B2 of the other part 4B1.

[0050] Preferably, each part 4B1 has at least a side edge, indicated with 4B4 in the detail of Fig. 4, the function of which is to make sure that the radiant element 4A maintains its correct. position.

[0051] From the above it is clear how each heat dissipating element 4 of Fig. 4 consists of a radiant element 4A and a foil 4B of Fig. 2.

[0052] In Fig. 2, reference 5 indicates the electric contacts previously mentioned, each one being manufactured as an individual element apt for its mechanical and electric coupling to one end of the foils 4B. From the detail of Fig. 5 it can be noticed, in particular, how the terminals 5 practically consist of a simple plate having an end being cut and folded, so as to define at least three alternate wings 5A, between which the end of a dissipating element 4 (obtained as mentioned above by overlapping two extensions 4B2 of the parts 4B1 that form each foil 4B) can be inserted by interference.

[0053] Finally, reference 3 indicates the above intermediate elastic device, which in the above example consists of a simple wavy foil made from an electric and thermal conducting material, and therefore being appropriate for operating also as a heat dissipating means; in order to avoid any through flows of unheated air through the radiator R, the profile of such a foil is rather low with many undulations, so as to favour its dissipating function.

[0054] The assembly of the radiator R according to the present invention is very simple and can be realized, with reference to Figs. 1 and 2, as follows.

[0055] First of all, the dissipating elements 4 are realized in the required number, i.e. eight; as said above, this is obtained by folding both parts 4B1 forming each foil 4B and arranging between them the radiant element 4A obtained by a zigzag alternate folding of the aluminium thin plate; as mentioned, an edge 4B4 is preventively obtained on each part 4B1 of the foil 4B to make sure a correct position of the radiant element 4A is maintained. Subsequently, the terminals 5 are applied as previously described to one end of several dissipating elements 4. Four dissipating elements 4 then are stacked on the lower cross memb r 1A with three heat mitting elements 2 being interposed, each one consisting of a bar 2B and three resistors 2A; thus, two opposite plane

surfaces of each PTC resistor are in contact with the foils 2B of two different dissipating elements 4.

[0056] Now, the spring device 3 is placed on the fourth dissipating element 4 starting from the bottom, and four dissipating elements 4 are stacked on it, with three heat emitting elements 2 being interposed, the same as described above.

[0057] Then the upper cross member 1B is placed on the eighth-dissipating element 4, which is pressed towards the lower cross member 1A to cause a certain flexure of the elastic device 3.

[0058] In this condition, the side upright 1C on the right is inserted on the cross members 1A-1B, minding that the right sides of each heat emitting element 2 and of each dissipating element 4 are inserted in their respective seats 14 and passages 15 delimited in the upright 1C.

[0059] Obviously, following this operation, the right projections 11 of the cross members 1A-1B are inserted in the openings 12 of the upright 1C, and the relevant teeth 10A engage the relevant openings 13A of the extensions 13; it should be noticed, in this connection, that the teeth 10A are shaped for favouring an elastic stretching apart of the extensions 13 during the insertion, up to the complete engagement.

[0060] Now, through an operation like the previous one, the left side upright 1C is inserted on the cross members 1A-1B; obviously, the terminals 5 assembled on the left ends of some dissipating elements 4 protrudes outside the frame 1 through the passages 15, ensuring a correct connection of the radiator to an appropriate power supply source.

[0061] As it can be seen, the assembly of the radiator according to the present invention is performed through elementary operations and with the use of simple and cost-effective components. Following this assembly, the elastic device 3 ensures a constant elastic thrust on the two dissipating elements 4 it is in contact with, to the lower cross member 1A and the upper cross member 1B, respectively; this thrust will also be progressively transferred to all further components inside the frame 1 (i.e. heat emitting elements 2 and other dissipating elements 4).

[0062] In this way, the contact between the dissipating elements 4 and the PTC resistors 2A of the heat emitting elements 2 is ensured, for providing a continuous electric connection and a thermal exchange between the first and second ones. As it can be seen, according to the radiator of the present invention, only one elastic device 3 is enough to this purpose, instead of the two being required in EP-A-0 350 528.

[0063] This, in fact, is possible in as much as for the radiator described in the example of Fig. 1, the thrust generated by the elastic device 3 is directed towards the outside of the frame 1, instead of the inside, i.e. for pressing the dissipating elements 4 with the interposed heat emitting elements 2 towards the lower cross member 1A and upper cross member 1B.

[0064] In order to ensure the transmission of the thrust generated by the elastic device 3, a certain vertical translation within the passages 15 or seats 14 of the uprights 1C is preferably allowed to the dissipating elements 4, and possibly also to the heat emitting elements 2. However, it should be noticed that this is not strictly required, since both the thickness and material of the foils 4B and bars 2B are such to allow their flexure under the thrust generated by the elastic device 3.

[0065] Finally, it should be noticed how the spring device 3, though arranged in an intermediate zone, does not practically exert any opposition to the air flowing through the radiator R, but it contributes to dissipate heat in such an air.

[0066] Fig. 6 is a schematic representation of the electric configuration of the radiator of Fig. 1.

[0067] As it can be noticed, in this configuration the radiator according to the present invention is equipped with seven electric terminals 5, through which the radiator R is fed with a supply voltage, with the polarities (+ and -) being alternate at two adjacent terminals; the seven terminals 5 are connected to as many heat dissipating elements 4, whose surfaces abutted on the PTC resistors act as power conduction means; however, with reference to the two heat dissipating elements 4 in contact with the elastic device 3, it should be noticed that only one of them has a terminal 5: this in view of the fact that the elastic device 3 obviously operates as an electric conductor, by short-circuiting the two dissipating elements 4 on which it operates directly by thrust.

[0068] Based on such a consideration, it is clear how the number of electric terminals 5 required is in general terms equal to (nd - ne), where "nd" is the number of the dissipating elements 4 and "ne" the number of the elastic devices 3.

[0069] Fig. 7 illustrates a radiator R manufactured according to a possible variant embodiment of the present invention, where two elastic devices 3 are provided.

[0070] As it can be noticed, in this instance, the inside of the frame 1 is split by the elastic devices 3 in three different housing zones for the heat emitting elements 2 and dissipating elements 4; namely:

- a lower zone, extending between the lower cross member 1A and the lower elastic device 3, housing two dissipating elements 4 with an interposed heat emitting element 2;
- an upper zone extending between the upper cross member 1A and the upper elastic device 3, housing two dissipating elements 4 with an interposed heat emitting element 2;
- a central zone extending between the two elastic devices 3, housing three dissipating elements 4 with two interposed heat emitting elements 2.

[0071] As it will be noticed, the number of heat emitting elements 2 provided is, as in the case of Fig. 1, [(nd - ne) - 1], where "nd" is the number of dissipating ele-

ments 4 and "ne" the number of elastic devices 3.

[0072] The manufacturing system of the radiator represented in Fig. 7 is in fact very similar to the one of the radiator shown in Fig. 1; what changes, apart a different number of elastic devices 3 (two instead of one), heat emitting elements (four instead of six) and dissipating elements (seven instead of eight), is the way the side uprights 1C are assembled with reference to the number and position of the seats 14 and passages 15.

[0073] Also, in the case of Fig. 7, i.e. using two elastic devices 3, it is clear that a minor translation of the dissipating elements 4 and/or heat emitting elements 2 with respect to the uprights 1C will be eventually possible, said translation, as already mentioned, being the result of the individual translations due to the elastic thrust generated by the elastic devices 3. In the instance of the radiator represented in Fig. 7, it will be possible to further constrain the ends of the dissipating and/or heat emitting elements with respect to Fig. 1, i.e. in other terms, the higher is the number of elastic devices 3, the less will be the vertical translation capacity of said ends within the passages 15 or seats 14 of the uprights 1C.

[0074] It is also pointed out that the radiator according to the present invention represented in Fig. 7 compared to the prior art represented by EP-A-0 350 528 ensures with an equal number of elastic devices 3 a more regular and efficient thrust distribution.

[0075] In the case of the above cited figure, in fact, a portion of the thrust generated by each elastic device 3 will be directed towards the center of the frame 1, to press some dissipating elements 4 with the interposed heat emitting elements 2 between them, whereas another portion of the thrust is directed towards the outside the frame 1, i.e. to press some dissipating elements 4 with the interposed heat emitting elements 2 towards the lower cross member 1A and upper cross member 1B of the frame 1.

[0076] Fig. 8 shows schematically the electric configuration of the radiator of Fig. 7, which is substantially similar to the radiator of Fig. 1, in particular for the function of the elastic devices 3 as electric conductors, by short-circuiting the pairs of dissipating elements 4 on which they operate. As it will be noticed, in this case, only five terminals are required, i.e. a number equal to the number of dissipating elements 4 (seven) less the number of elastic devices 3 (two); also in this case the polarity of the supply voltage to the set of terminals 5 is staggered.

[0077] The various parts of Fig. 9 represent, through respective plan views and side views, some variant embodiments of the elastic device 3 shown in the previous figures, which are manufactured starting from a metal strap, wherein elastic foils are delimited through a precutting and folding operation.

[0078] In the case of part A of Fig. 9 two sets of elastic foils 21A1 e 21A2 are provided, in positions substantially parallel and staggered between them, each one of them departing from the plane delimited by the strap 20B in one sole direction, i.e. downwards, with reference to the figure. In th case of part B of Fig. 9 two sets of lastic foils 21B1 and 21B2 are provided, in positions being substantially parallel and aligned to each other, but departing from the plane delimited by the strap 20B in both directions, i.e. downwards and upwards; as it will be noticed, in this instance the foils 21B1 and 21B2 of both sets are either directed or inclined to opposite directions.

[0079] In the case of part C of Fig. 9 two sets of elastic foils 21C1 and 21C2 are provided, in positions substantially parallel, which depart from the plane delimited by the strap 20C in both directions like the previous case; however, in this case the foils 21C1 and 21C2 of both sets are in a smaller number and staggered between them.

[0080] In the case of part D of Fig. 9 four sets of elastic foils 21D1, 21D2, 21D3 and 21D4 are provided, in positions substantially parallel, which depart from the plane delimited by the strap 20D in both directions; as it can be noticed, the foils 21D1 and 21D3 of the sets directed upwards face each other; the same applies to the foils 21D2 and 21D4 of the sets directed downwards. In the case of part E of Fig. 9 four sets of elastic foils 21E1, 21E2, 21E3 and 21E4 are provided, in positions substantially parallel and staggered two by two, which depart from the plane delimited by the strap 20D in both directions; as it can be noticed, the foils 21E1 and 21E2 of the sets directed upwards face opposite directions, crossing each other when viewed in side direction; the same applies to the foils 21E3 and 21E4 of the sets directed downwards. Finally, in the case of part F of Fig. 9 two sets of elastic foils 21F1 and 21F2 are provided in positions being substantially parallel and staggered between them, each one of them departing from the plane delimited by the strap 20A in one sole direction, i.e. downwards with reference to the figure; as it will be noticed, the foils 21F1 and 21F2 are directed in opposite directions, crossing each other when viewed in side direction.

[0081] Therefore, as it can be seen according to the present invention, a wide range of elastic devices can be provided to warrant a contact between the various components of the radiator, for ensuring heat or power transmission.

[0082] In the cases being illustrated in Fig. 9, the free ends of the various elastic foils have a certain curving degree; however, they may be clearly plane or have a different shape and/or distribution and/or thickness, so as to favour the electric contact with the radiator dissipating elements 4, for improving the thermal exchange and for obtaining optimal forces distribution.

[0083] From the above description the features of the present invention and the advantages thereof are clear. In particular it should be highlighted:

- the extremely simple manufacture of the components required for obtaining the radiator and its easy assembly;

- the even and efficient distribution of the thrust generated by the elastic devices provided;
- the elastic devices being provided do not determine any negative results for the air flow to be heated; on the contrary, they are directly exposed to the air flowing through the radiator, so as to operate like heat dissipating elements and contribute to air heating;
- the elastic devices being provided can be employed as electric conducting elements for making the heater supply system a simpler and decrease the number of the electric terminals of the radiator.

[0084] It is obvious that many changes are possible for the man skilled in the art to the electric radiator described above by way of example, without departing from the novelty spirit of the inventive idea.

[0085] For example, in order to further reduce the number of electric terminals 5, the radiator according to the present invention may advantageously be provided with one or more contacting means or bridges, each one of them being destined to electrically interconnect several dissipating elements 4 of equal polarity.

[0086] Fig. 10 illustrates a possible embodiment of such a contact bridge, indicated with 30, which consists substantially of a strap 30A made from electric conducting material, being cut and folded for presenting orthogonal foils 30B, generally in the same number of the dissipating elements 4 to be connected to each other, or in a number being equal to the number of such dissipating elements 4 less the number of elastic devices 3.

[0087] According to this variant embodiment, instead of a plurality of seats 14 and passages 15, the upright 1C has a proper recess, wherein the bridge 30 can be freely inserted during the coupling operation of the upright itself with the cross members 1A and 1B of the radiator frame 1.

[0088] In the instance of Figs. 11 and 12, wherein the upright 1C is not represented, the contacting bridge 30 is so assembled to have the strap 30A arranged sideways with respect to the ends indicated with 4B2 of the dissipating elements 4; as it will be noticed, the foils 308 of the bridge 30 are only in contact with the ends 4B2 of the dissipating elements 4, to be electrically interconnected; the electric and mechanical contact between said foils 30B and the relevant ends 4B2 may be warranted for example through electric tacking or welding or riveting, etc..

[0089] It should be noticed how the width of the ends 2B2 of the bars 2B pertaining to the heat emitting elements 2 is larger than the width of the end 4B2 of the dissipating elements 4; as a result, this prevents the strap 30A from coming into contact with the ends 4B2 of the dissipating elements 4 of different polarities, i.e. those that are not to be interconnected by the bridge 30.

[0090] In the case of Fig. 13, vice-versa, the contacting bridge 30 is assembled with the strap 30A being arranged on the front with respect to the ends 4B2 of the dissipating elements 4; as it will be noticed, also in this instanc th foils 30B of the bridge 30 are only connect- d to said nds 4B2 of the dissipating lements 4 to be electrically interconnected.

[0091] With reference to this embodiment, it should be noticed how the ends 2B2 of the various positioning bars 2B of the PTC resistors extend over the point reached by the ends 4B2 of the dissipating elements 4; therefore, also in this instance, the ends 2B2 act as "spacers", so as to prevent that the strap 30A may come into contact with the ends 4B2 of the dissipating elements 4 of different polarities, i.e. those that are not to be interconnected through the bridge 30.

[0092] Fig. 14 illustrates the principle of electric connection of a radiator like the one of Fig. 1 (but with an elastic device as illustrated in part D of Fig. 9) should only one contacting bridge 30 be employed.

[0093] As it will be noticed, the dissipating elements 4 subject to negative polarity are connected to each other through the bridge 30, whereas the dissipating elements 4 subject to positive polarity have respective terminals 5; of course, also one of the dissipating elements subject to negative polarity has a terminal 5 (first one from the top) to facilitate the radiator connection to the relevant power source; it is also clear how the right upright (with reference to Fig. 14) of the radiator frame will be of the type with only one housing seat for the bridge 30, whereas the left upright will be of the type with the seats 14 and passages 15 (see Fig. 2).

[0094] As it can be noticed, for example by a comparison of Fig. 14 with Fig. 6, the use of the contacting bridge 30 decreases the number of terminals 5 projecting out from the radiator frame (four terminals 5 in the instance of Fig. 14 compared to seven of Fig. 6).

[0095] Fig. 15, on the contrary, illustrates the principle of electric connection of a radiator as shown in Fig. 2 (but with two elastic devices like in part D of Fig. 9) in the event of only one contacting bridge 30 being used.

[0096] As it will be noticed, also in-this instance the dissipating elements 4 subject to negative polarity are interconnected by the bridge 30, whereas the dissipating elements 4 subject to positive polarity have their respective terminals 5; as for the previous case, one negative polarity dissipating element is anyway equipped with a terminal 5, while the side uprights of the radiator frame are of different type between them.

[0097] Also in this configuration, comparing for example Fig. 15 with Fig. 7, it appears how the use of the contacting bridge 30 reduces the number of terminals 5 projecting from the radiator frame (three terminals 5 in Fig. 15 against five of Fig. 7).

[0098] Figs. 16 and 17 illustrate the principle of electric connection of two radiators like those of Figs. 14 and 15, should two contacting bridges be employed.

[0099] In the case of Fig. 16, the dissipating elements 4 subject to negative polarity are interconnected by a bridge 30' having four contact foils (i.e. foils 30B of Figs. 10-12), whereas the dissipating elements 4 subject to

positive polarity are interconnected by a bridge 30" having three contact foils.

[0100] In the cas of Fig. 17, vice-versa, the dissipating elements 4 subject to positive polarity are interconnected by a bridge 30' having three contact foils, whereas the dissipating elements 4 subject to negative polarity are interconnected by a bridge 30" having two contact foils.

[0101] In both cases, one of the dissipating elements subject to positive polarity is equipped with a terminal 5 and the bridge 30" interconnecting the dissipating elements subject to negative polarity is also equipped with a terminal 5, thus favouring connection of the radiator to the relevant power source.

[0102] The right uprights of both radiator frames shown in Figs. 16 - 17 has a proper housing recess for the bridge 30', whereas the left upright besides such a housing recess also has two passages 15 for the terminals 5 there available.

[0103] As it can be noticed in Figs. 16 - 17, the use of two contacting bridges 30' and 30" limits to only two the number of terminals 5 projecting from the radiator frame.

[0104] In the description of Figs. 14-17 reference has been made to the use of side uprights 1C on the radiator frame, which have a different shape between them; however, it is clear that nothing hinders manufacturing the uprights 1C in such a way to have both a housing recess for the contacting bridge and a plurality of seats 14 and passages 15 (Fig. 2) in order to improve the manufacturing standardization.

[0105] In the examples previously described and illustrated the elastic devices 3 are arranged between two dissipating elements 4; according to further possible embodiments, on the other hand, the elastic devices 3 may be interposed between two heat emitting elements 2; such an example is represented schematically in Fig. 18, showing an elastic device 3 arranged in an intermediate position between two heat emitting elements 2, which operates to push them to respective opposite directions; obviously, should at least two elastic devices 3 be used, each one of them will operate to push one of the respective heat emitting elements 2 to a first cross member (1A or 1B), and the other to a median or central zone of the frame 1.

[0106] Then, nothing hinders to realize combinations providing at least an elastic device between two dissipating elements 4 and at least an elastic device between two heat emitting elements 2, or still comprising at least an elastic device between a heat emitting element 2 and a dissipating element 4.

[0107] According to a further possible embodiment, at least an elastic device 3 may be provided for its coupling to a respective electric terminal 5, either in the instance where the elastic device itself is placed between two heat emitting elements (as illustrated in Fig. 18), and in the case it is placed between two dissipating elements 4 or between a dissipating element and a heat emitting element; in these further circumstances, of course, said dissipating elements will not require any respective terminal 5.

[0108] It is also pointed out how th bars 2B pertaining to the heat emitting elements 2 may advantageously have a higher number of openings 2B1 compared to the number of PTC resistors 2A actually cooperating with this bar; this case is in fact highlighted in Fig. 2, where the bar indicated with 2B has six openings 2B1, but only three of them receives an equal number of PTC resistors 2A.

[0109] Therefore, the three PTC resistors of a bar 2B can have a staggered position with respect to the three PTC resistors of the subsequent bar 2B, as highlighted in the above Fig. 18 (wherein the bars 2B are not represented).

[0110] From the above it is apparent how according to the present invention an optimal distribution of the PTC resistors can be obtained inside the radiator, using only one standardized bar 2B.

[0111] If required, PTC resistors may be replaced by different suitable heating means.

Claims

1. A radiator, in particular for the use on motor vehicles, comprising a supporting body (1), where one or more heat emitting elements (2) extend between two first sides (1C) of said supporting body, said heat emitting elements (2) comprising one or more electric resistors (2A), in particular of the positive temperature coefficient type, said heat emitting elements (2) being in contact with at least a heat dissipating element (4), the latter being in particular mounted in said supporting body (1) substantially parallel to the heat emitting element (2) in contact with it, where elastic means (3) are further provided in said supporting body (1), which generate a thrust to press at least one of the dissipating elements (4) being provided on at least one of the heat emitting-elements-(-2)-being-provided, or vice-versa, **characterized in that** said elastic elements comprise at least an elastic device (3) which is arranged in an intermediate position between two dissipating elements (4) and/or between two heat emitting elements (2) and/or between a dissipating element (4) and a heat emitting element (2), said elastic device (3) being operative for pushing them to respective opposite directions.

2. A radiator, according to claim 1, **characterized in that** said elastic device (3) is provided for pushing each one of said two dissipating elements (4) and/or said two heat emitting elements (2) and/or said dissipating element (4) and heat emitting element (2) towards a respective second side (1A,1B) of said supporting body (1), said second sides (1A,1B) extending in a direction substantially perpendicular

with respect to the extending direction of said first sides (1C).

3. A radiator, according to claim 1 or 2, **characterized in that** a single elastic device (3) is provided, which operates for generating a thrust directed towards the outside of said supporting body (1).

4. A radiator, according to claim 1 or 2, **characterized in that** at least two elastic devices (3) are provided, each one of them being operative for generating a thrust directed at least partially towards the outside of said supporting body (1), or towards one of said second sides (1A,1B), and directed at least partially towards the inside of said supporting body (1).

5. A radiator, according to claim 1, **characterized in that** said elastic device or devices (3) are directly exposed to the air flow crossing the radiator (1), so as to operate as heat dissipating means and contribute to the heating of the air itself.

6. A radiator, according to at least one of the previous claims, **characterized in that** said body comprises a frame (1), where said first sides include two uprights (1C) of said frame (1) and said second sides include an upper cross member (1B) and a lower cross member (1A) of said frame (1), said body or frame (1) being in particular manufactured from an electric and/or thermal insulating material, such as thermoplastic material.

7. A radiator, according to at least one of the previous claims, **characterized in that** said heat emitting elements (2) are inserted at least at one of their ends (2B2) in seats (14) defined in said first sides or uprights (1C) and/or said dissipating elements (4) are inserted at least at one of their ends (4B2) in passages (15) defined in said first sides or uprights (1C).

8. A radiator, according to at least one of the previous claims, **characterized in that** said elastic device or devices (3) extend parallel with respect to said heat emitting elements (2) and/or said dissipating elements (4).

9. A radiator, according to at least one of the previous claims, **characterized in that** at least two of said dissipating elements (4) are in contact, on one side, with said second sides or cross members (1A,1B), and on the other side with a respective heat emitting element (2) and/or at least two of said dissipating elements (4) are in contact, on one side, with an elastic device (3), and on the other side with a respective heat emitting element (2).

10. A radiator, according to at least one of the previous claims, **characterized in that** said heat emitting elements (2) comprise each one a positioning el - ment (2B) made from electric insulating material, having a plurality of through-openings (2B1), each one of said through-openings (2B1) being apt for retaining at least one of said resistors (2A), said positioning element (2B) also operating in particular as an electric insulator.

11. A radiator, according to at least one of the previous claims, **characterized in that** at least two of said dissipating elements (4) comprise each one at least a radiant element (4A).

12. A radiator, according to the previous claim, **characterized in that**- said radiant element consists of a thin foil (4A) made from a good heat and power conducting material, in particular folded on itself to form angles or bends alternated on one or the other side.

13. A radiator, according at least one of the previous claims, **characterized in that** each one of said dissipating elements (4) comprises means for containing said radiant element (4A), which are made from a foil in metal material (4B) having two parts (4B1) folded on each other for packing said radiant element (4A).

14. A radiator, according to at least one of the previous claims, **characterized in that** said dissipating elements (4) and/or said heat emitting elements (2) have a certain vertical translation capacity with respect to said first sides or uprights (1C).

15. A radiator, according to at least one of the previous claims, **characterized in that** said elastic device (3) is made starting from a metal strip (20A-20F), whereon elastic foils are defined (21A-21F).

16. A radiator, according to at least one of the previous claims, **characterized in that** at least a contacting means or bridge (30) is provided for electrically connecting some of said dissipating elements (4) subject to a first electric polarity.

17. A radiator, according to the previous claim, **characterized in that** means are provided for maintaining said contacting bridge (30) electrically insulated from the dissipating elements (4) subject to a second electric polarity, said means comprising in particular appropriately shaped ends (2B2) of said heat emitting elements (2).

18. A radiator, according to at least one of the previous claims, **characterized in that** said contacting bridge (30) comprises portions (30B) being destined to electric and mechanical connection to at least one end (4B2) of as many dissipating ele-

ments (4) subject to one same electric polarity.

19. A radiator, according to at least one of the previous claims, **characterized in that** a seat for housing said contacting bridge (30) is defined in at least one of said uprights (1C).

20. A radiator, according to claim 1, **characterized in that** said heat emitting elements (2) comprise each one a plurality of said electric resistors (2A) and that the resistors (2A) of a heat emitting element (2) are staggered with respect to the resistors (2A) of a subsequent heat emitting element (2).

FIG. 1

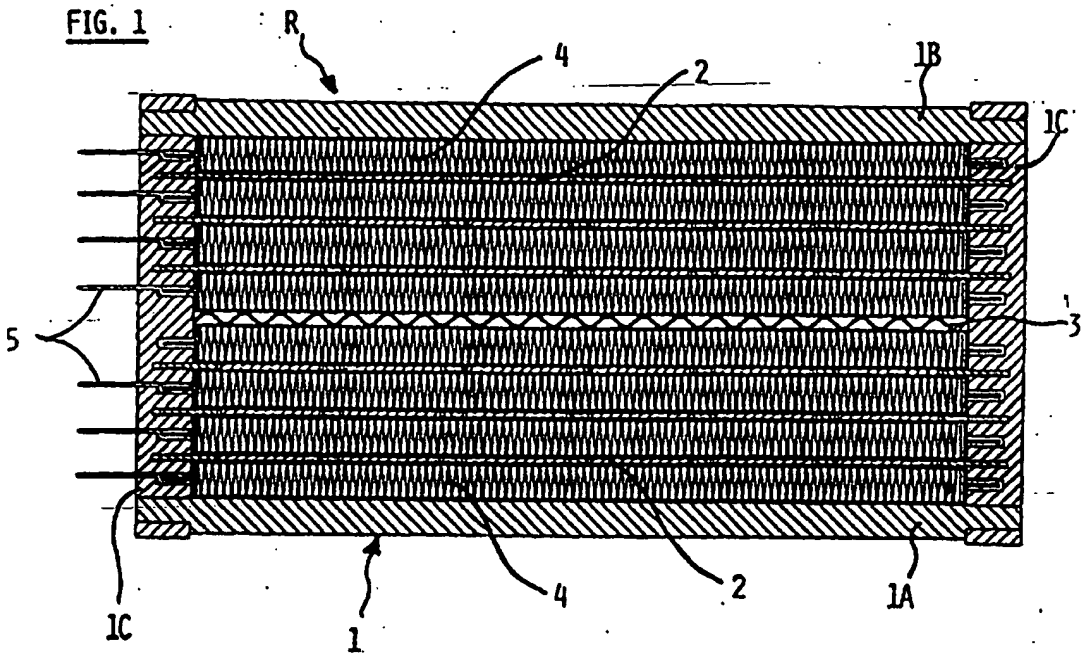
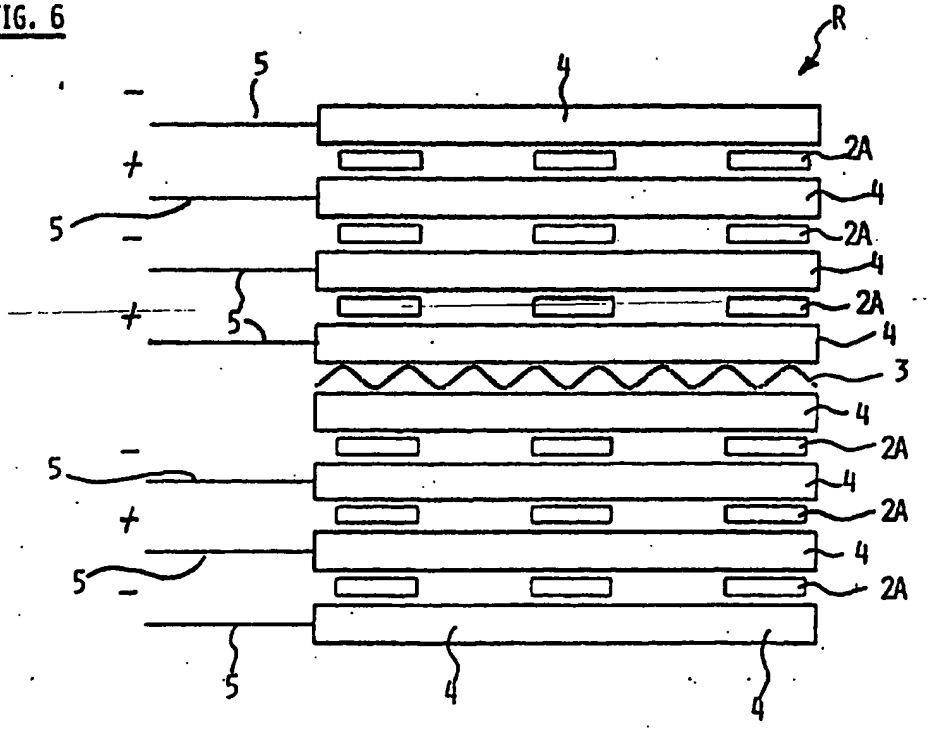


FIG. 6



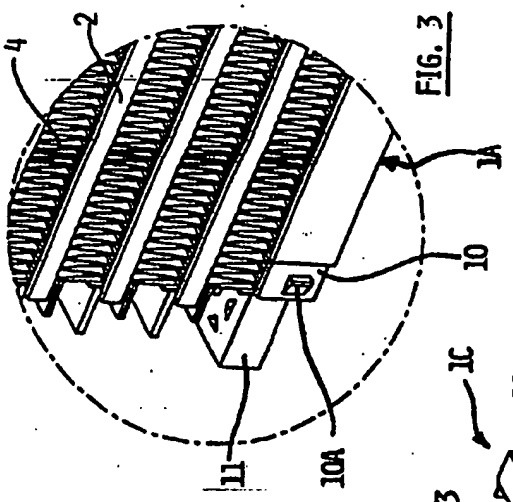
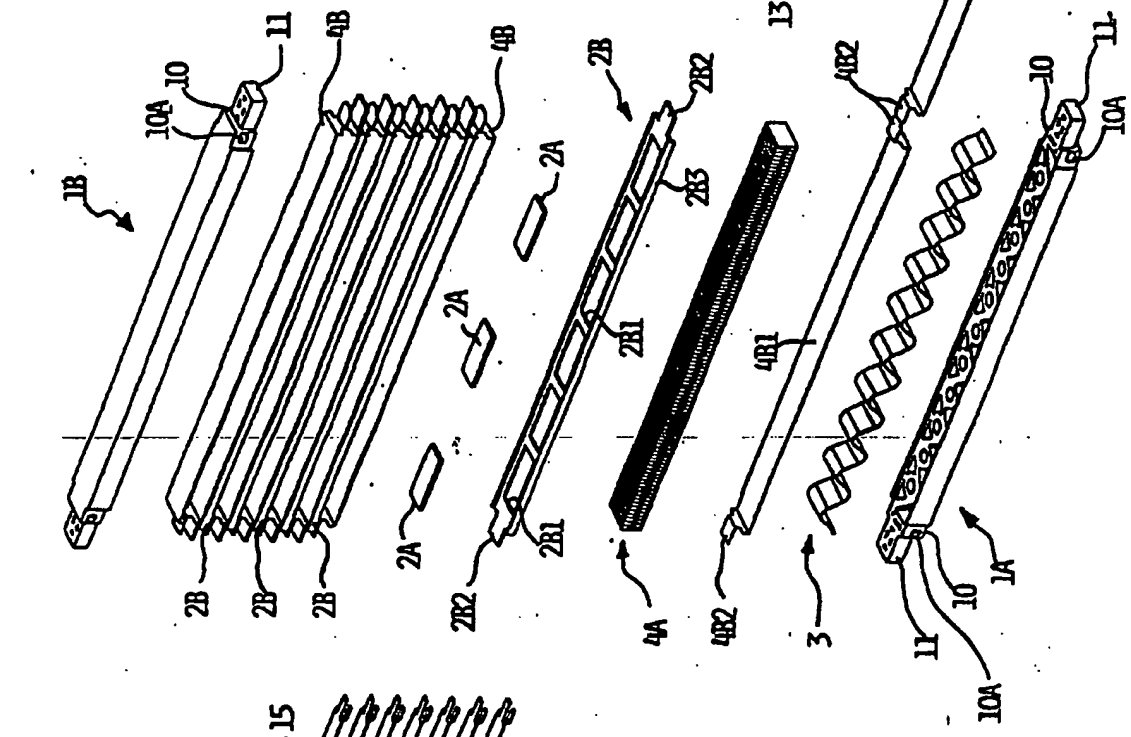

4
2
1A
10
11
10A

FIG. 3


1C
12
15
12
13
13A
13
13A
4B
4B2
4B1
1B
10A
10
11
4B
4B
2B
2B2
2A
2A
2A
2B3
2B1
2B1
2B2
2B
2B
2B
4A
4B2
4B1
4B2
3
11
10
1A
10A

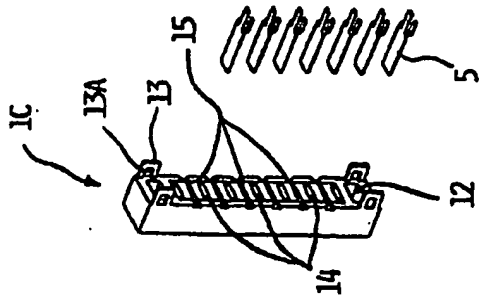

15
5
1C
13A
13
12
14

FIG. 2

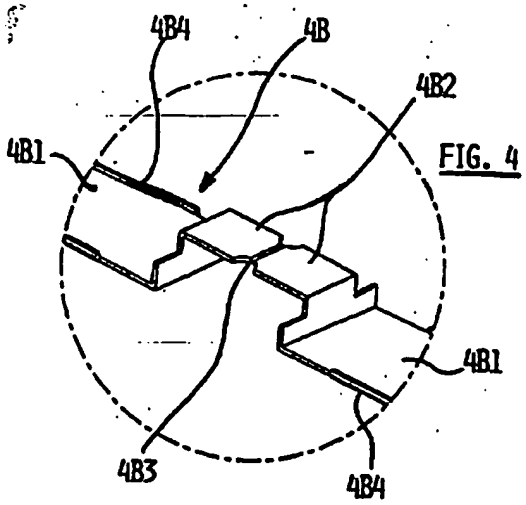


FIG. 4

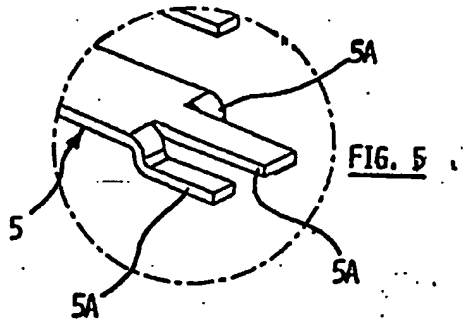


FIG. 5

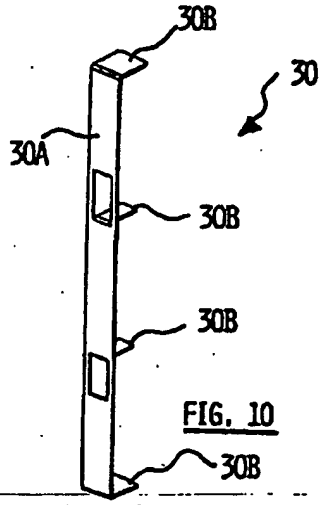


FIG. 10

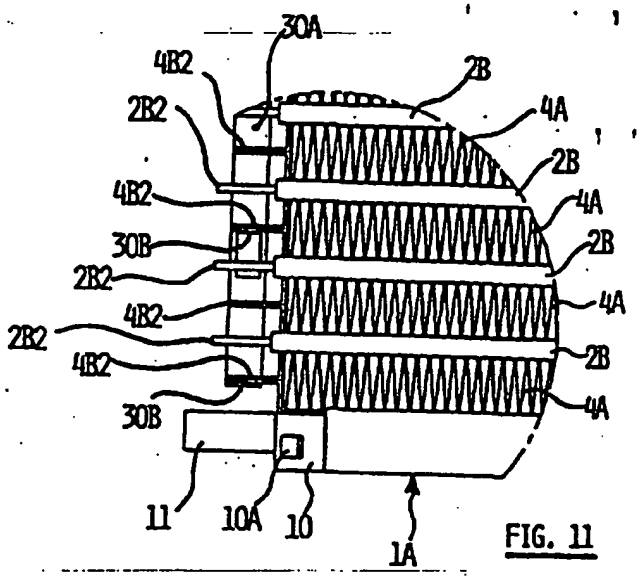


FIG. 11

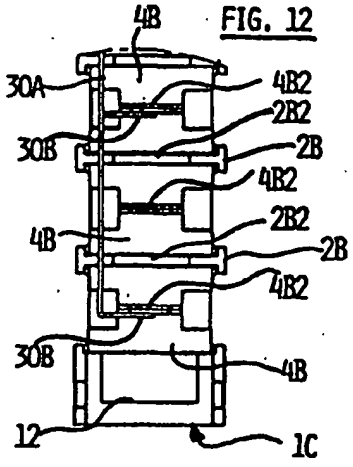


FIG. 12

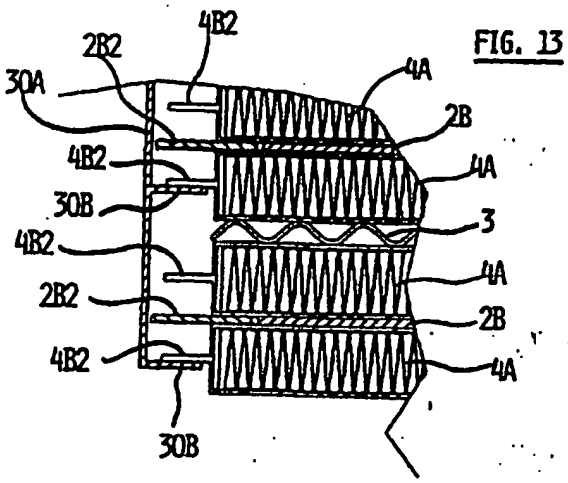


FIG. 13

FIG. 7

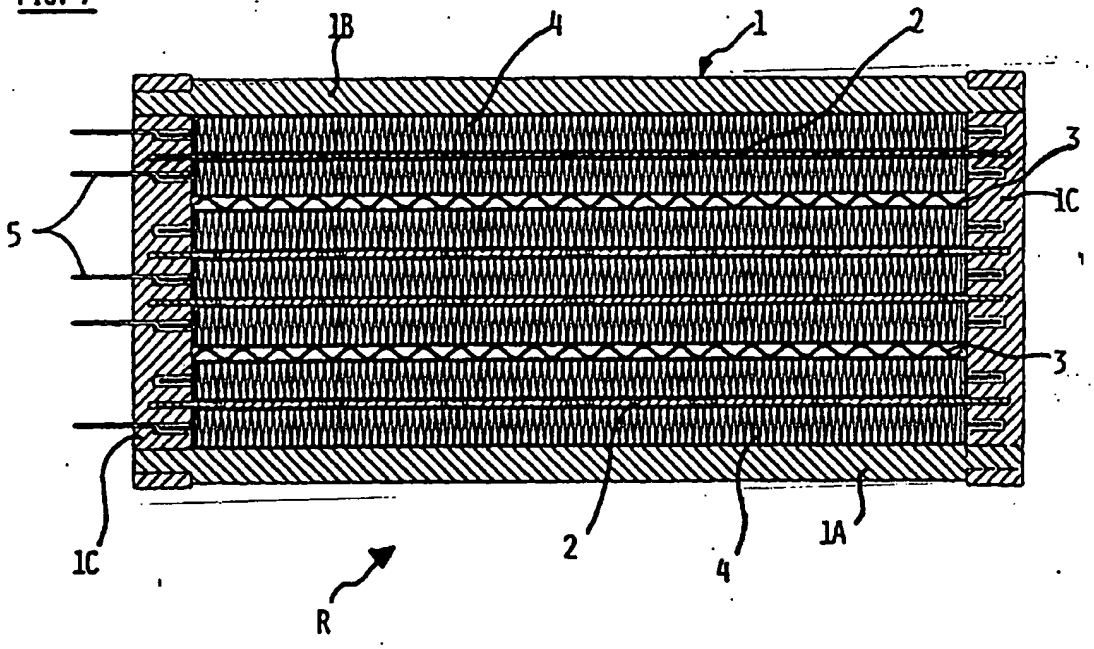


FIG. 8

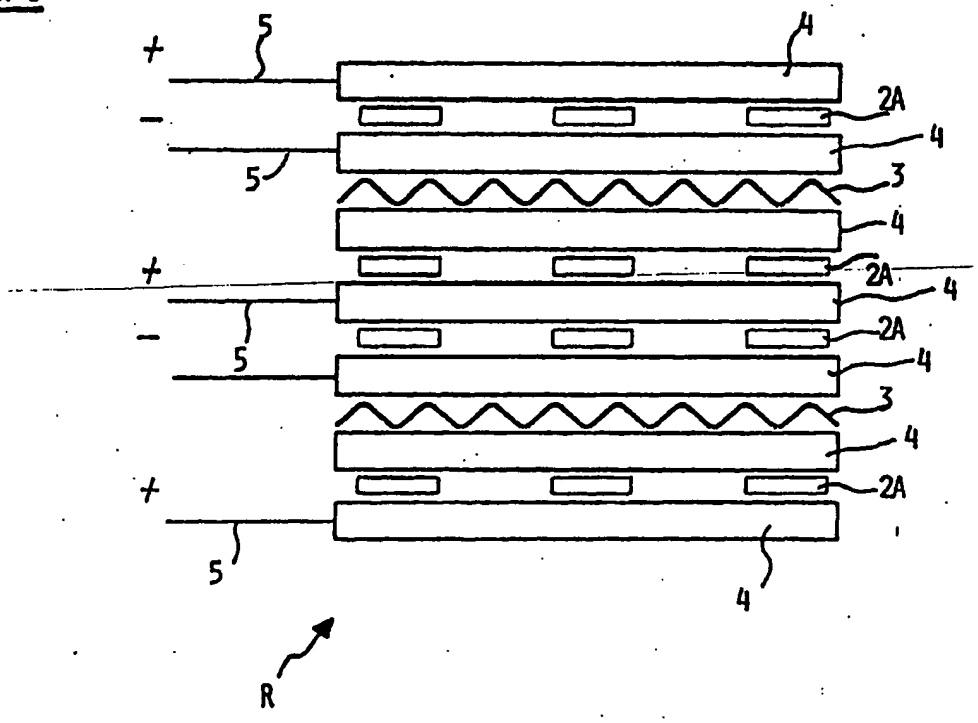
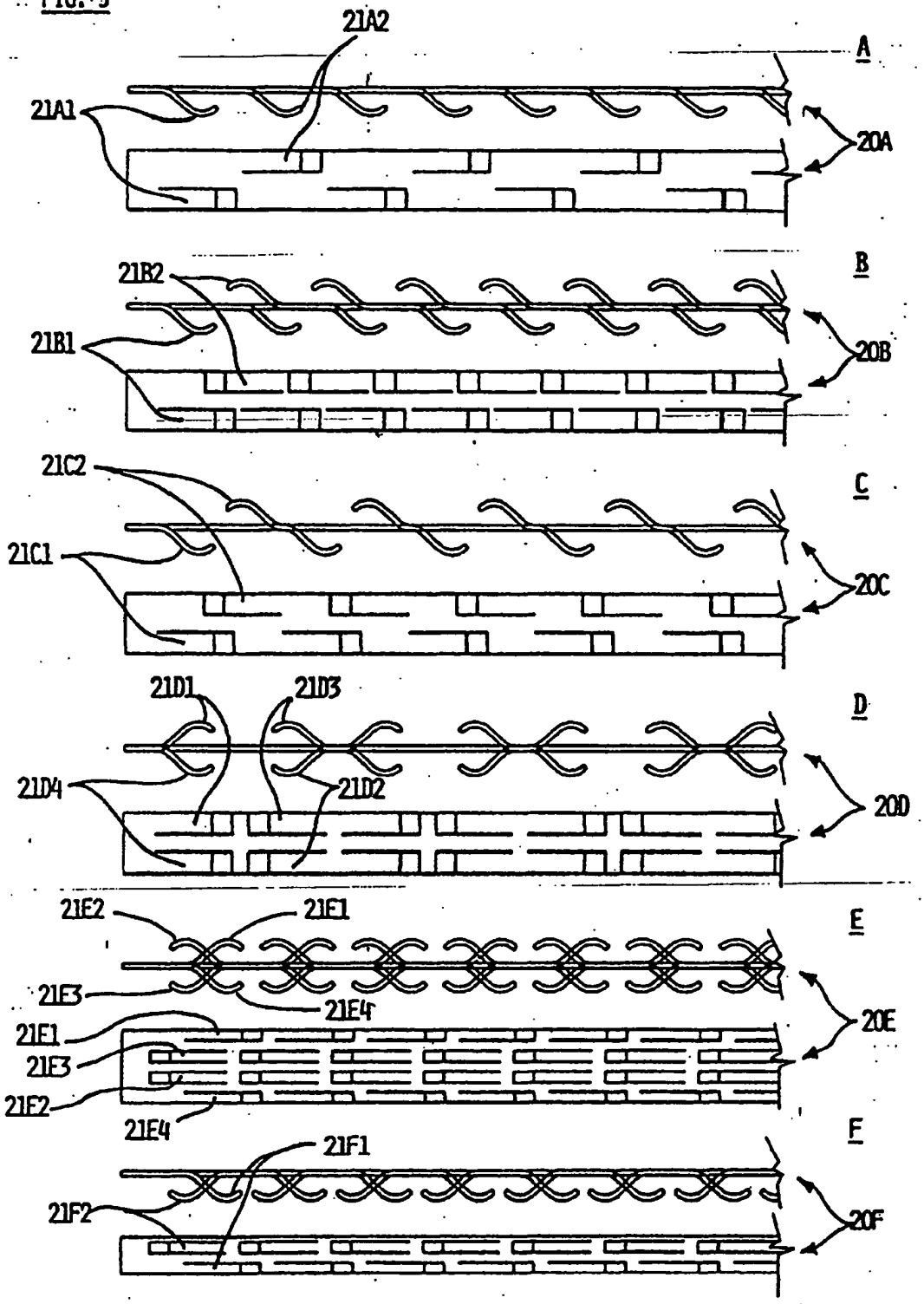


FIG. 9


21A2
A
21A1
20A
21B2
B
21B1
20B
21C2
C
21C1
20C
21D1
21D3
D
21D4
21D2
20D
21E2
21E1
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21E4
21E1
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20E
21E2
21E4
21F1
F
21F2
20F

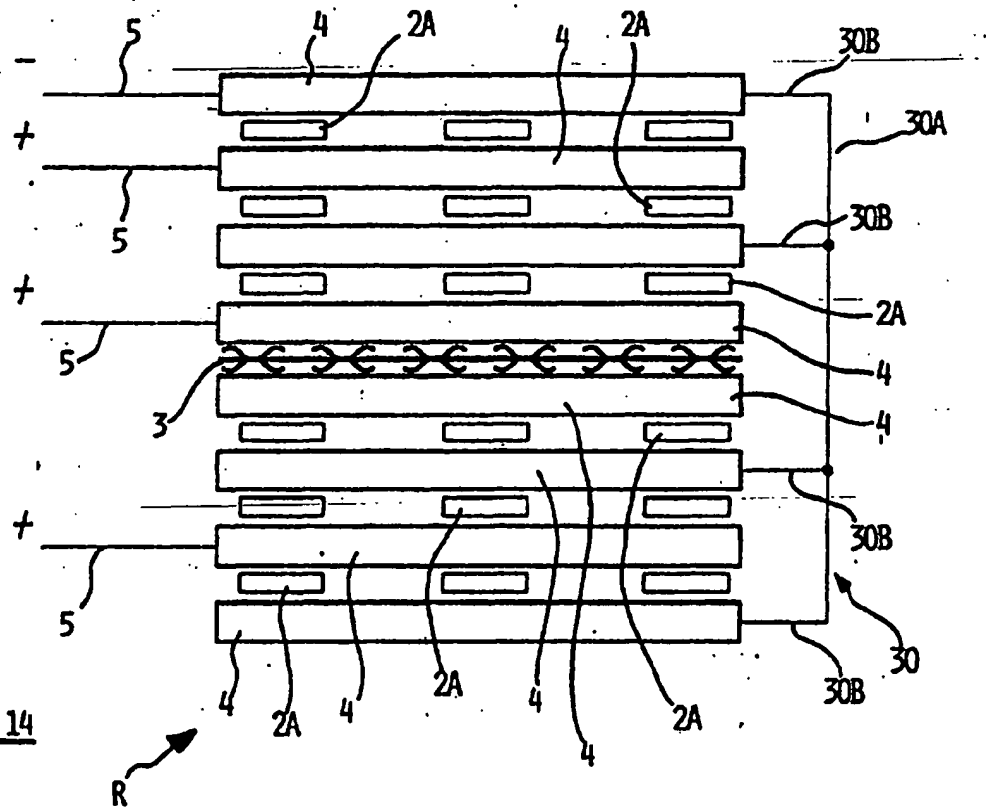
5
4
2A
4
2A
30B
30A
+
5
30B
+
2A
5
4
3
4
+
30B
5
30
30B
4
2A
4
2A
4
2A
4
R

FIG. 14

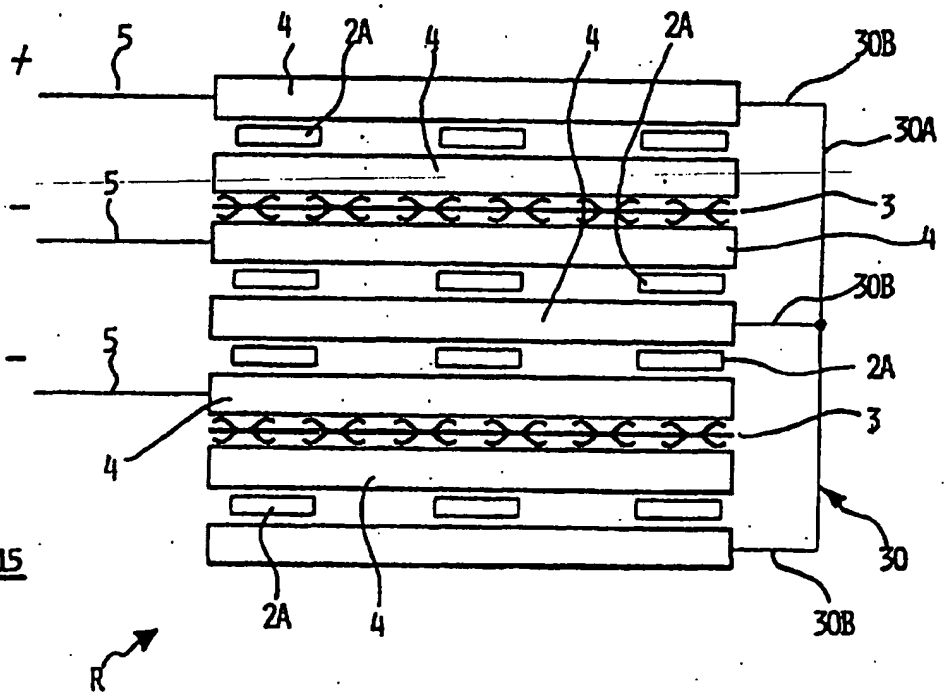
+
5
4
2A
4
4
2A
30B
30A
5
3
4
30B
5
2A
3
4
30
2A
4
30B
R

FIG. 15

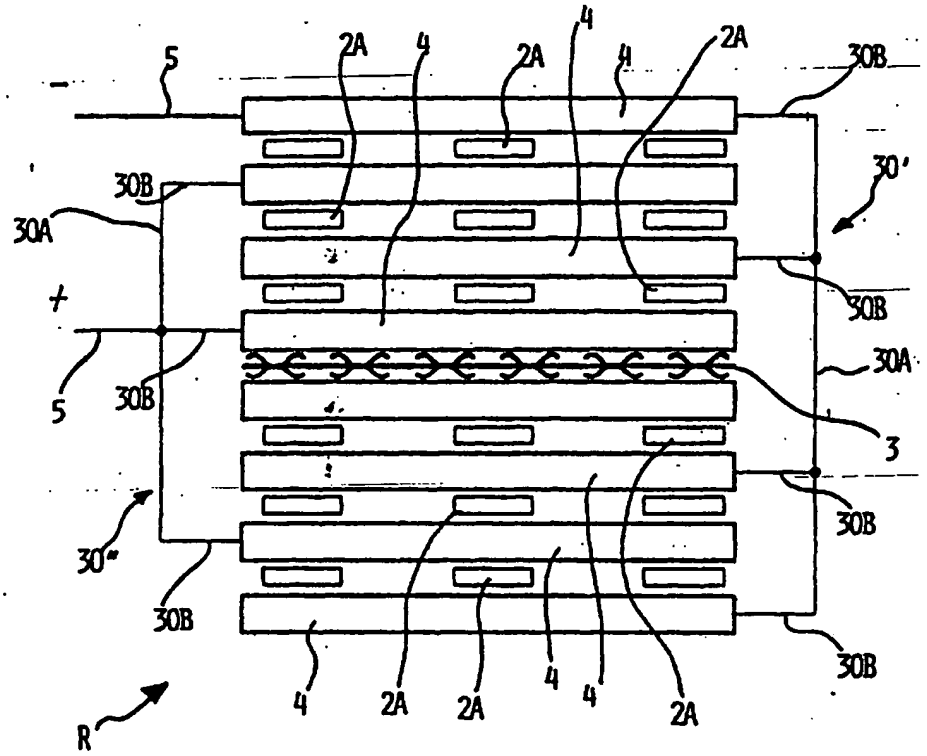
5
2A
4
2A
4
4
2A
30B
30'
30B
30A
+
5
30B
30A
3
30B
30"
30B
30B
4
2A
2A
4
4
2A
R

FIG. 16

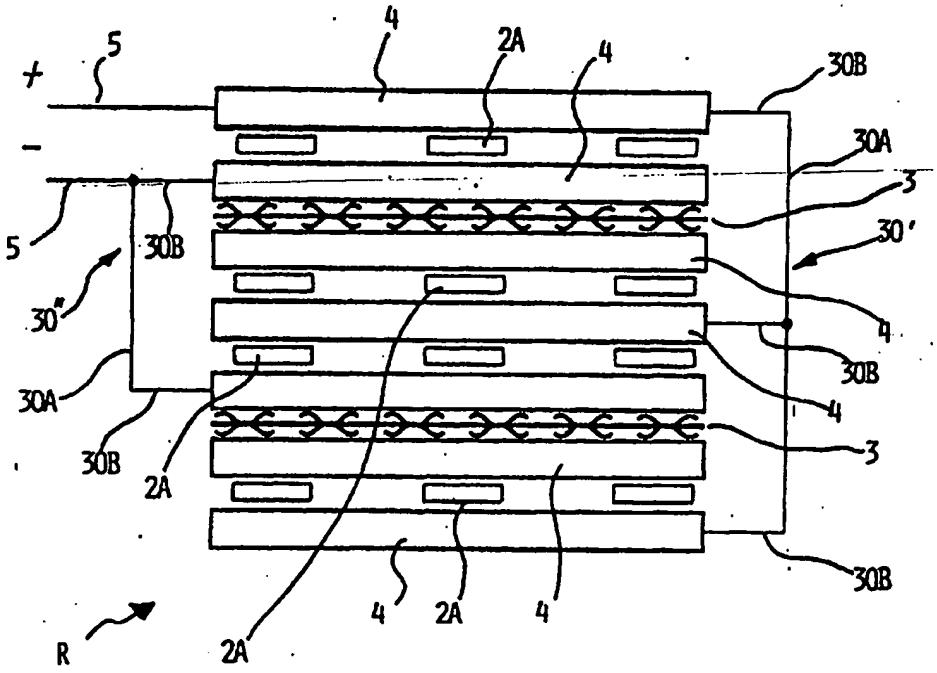
4
2A
4
30B
+
5
30A
3
5
30B
30'
30"
4
30B
30A
4
30B
2A
3
30B
4
2A
4
R
2A

FIG. 17

FIG. 18